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(54) Title: **SILOXANE DRY CLEANING COMPOSITION AND PROCESS**

(57) Abstract: A dry cleaning composition comprising a volatile siloxane and a mixture of different classes of organic surfactants and, optionally water, and a method for dry cleaning comprising contacting an article with a composition comprising a volatile siloxane and a mixture of different classes of organic surfactants.

WO 02/50366 A1

SILOXANE DRY CLEANING COMPOSITION AND PROCESS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims rights of priority from U.S. Provisional Patent Application Serial No. 60/187,204, filed March 3, 2000.

TECHNICAL FIELD

The present invention is directed to a dry cleaning composition, more specifically, to a siloxane fluid based composition, for use in dry cleaning and to a dry cleaning process using the composition.

BACKGROUND

Current dry cleaning technology uses perchloroethylene ("PERC") or petroleum-based materials as the cleaning solvent. PERC suffers from toxicity and odor issues. The petroleum-based products are not as effective as PERC in cleaning garments.

Cyclic siloxanes have been reported as spot cleaning solutions, see US 4,685,930, and as dry cleaning fluids in dry cleaning machines, see US 5,942,007. Other patents disclose the use of silicone soaps in petroleum solvents, see JP 09299687, and the use of silicone surfactants in super critical carbon dioxide solutions has been reported, see, for example, US 5,676,705 and Chem. Mark. Rep., 15 Dec 1997, 252(24), p. 15. Non-volatile silicone oils have also been used as the cleaning solvent requiring removal by a second washing with perfluoroalkane to remove the silicone oil, see JP 06327888.

Numerous other patents have issued in which siloxanes or organomodified silicones have been present as addenda in PERC or

petroleum based dry cleaning solvents, see, for example, WO 9401510; US 4911853; US 4005231; US 4065258.

There is a continued interest in providing an additive or additives to enhance the cleaning ability of silicone based dry cleaning solvents.

SUMMARY OF THE INVENTION

5 In a first aspect, the present invention is directed to a dry cleaning composition, comprising a volatile siloxane and two or more surfactants.

In a second aspect, the present invention is directed to a method for dry cleaning an article, comprising contacting the article with a composition comprising a volatile siloxane and two or more surfactants.

10 In a third aspect, the present invention is directed to a concentrate composition, comprising two or more surfactants.

The composition and process of the present invention exhibit improved performance, such as for example, removal of water soluble stains from the article, for example a garment, being cleaned, improved feel and
15 hand, and improved refinishing of the article. The present invention also provides for the removal of oil soluble stains such as motor oil and grease.

DETAILED DESCRIPTION OF THE INVENTION

In a preferred embodiment, the composition comprises, based on 100 parts by weight ("pbw") of the composition, from greater than 90 pbw to 99.99 pbw, more preferably from 92 pbw to 99.9 pbw and even more
20 preferably from 95 pbw to 99.5 pbw of the volatile siloxane and from 0.001 pbw to less than 10 pbw, more preferably from 0.01 pbw to 8 pbw and even more preferably from 0.1 pbw to 5 pbw of the surfactants. The composition optionally further comprises water, preferably from 0.01 pbw to 15 pbw, more

preferably from 0.1 pbw to less than 12 pbw and even more preferably from 0.2 pbw to 10 pbw of water. The volatile siloxane utilized in the present invention may be a linear, branched or cyclic siloxane.

5 In a preferred embodiment, the water may be added as "free" water or may be delivered by an emulsion containing other components such as siloxanes, hydrocarbons, surfactants, or other suitable additives. If the water is delivered by an emulsion, the emulsion may be prepared by such methods as homogenization of the components or mechanical stirring of the mixture.

10 In a preferred embodiment, the surfactant comprises two or more organic surfactants selected from the classes of nonionic, cationic, anionic and amphoteric surfactants. In one preferred embodiment, two organic surfactants are mixed together for use in the composition. In another preferred embodiment, three organic surfactants are mixed together for use in the composition. In another preferred embodiment, four organic surfactants
15 are mixed together for use in the composition. In another preferred embodiment, five organic surfactants are mixed together for use in the composition. In another preferred embodiment, more than five organic surfactants are mixed together for use in the composition.

20 In another preferred embodiment of the present invention, a concentrate composition comprises two or more surfactants, preferably two or more organic surfactants selected from the classes of nonionic, cationic, anionic and amphoteric surfactants. The composition comprises, based on 100 pbw of the composition, from 0.1 to 99.9 pbw of one surfactant and from 0.1 to 99.9 pbw of a second surfactant. Optionally, the concentrate
25 composition may further comprise from 0.1 to 99.8 pbw of one or more additional organic surfactants. The concentrate composition may optionally further comprise a siloxane fluid. The concentrate composition may be added

to a cleaning fluid, for example a dry cleaning solvent, for use in cleaning processes.

Compounds suitable as the linear or branched, volatile siloxane solvent of the present invention are those containing a polysiloxane structure that includes from 2 to 20 silicon atoms. Preferably, the linear or branched, volatile siloxanes are relatively volatile materials, having, for example, a boiling of below about 300°C point at a pressure of 760 millimeters of mercury ("mm Hg").

In a preferred embodiment, the linear or branched, volatile siloxane comprises one or more compounds of the structural formula (I):



wherein:

M is $R^1_3SiO_{1/2}$;

D is $R^2R^3SiO_{2/2}$;

15 T is $R^4SiO_{3/2}$;

and Q is $SiO_{4/2}$

R^1 , R^2 , R^3 and R^4 are each independently a monovalent hydrocarbon radical; and

x and y are each integers, wherein $0 \leq x \leq 10$ and $0 \leq y \leq 10$ and $0 \leq z \leq 10$.

20 Suitable monovalent hydrocarbon groups include acyclic hydrocarbon radicals, monovalent alicyclic hydrocarbon radicals, monovalent and aromatic or fluoro containing hydrocarbon radicals. Preferred monovalent hydrocarbon radicals are monovalent alkyl radicals, monovalent aryl radicals

and monovalent aralkyl radicals. In a highly preferred embodiment, the monovalent hydrocarbon radical is a monovalent (C₁-C₆)alkyl radical, most preferably, methyl.

As used herein, the term "(C₁-C₆)alkyl" means a linear or branched
5 alkyl group containing from 1 to 6 carbons per group, such as, for example, methyl, ethyl, propyl, iso-propyl, n-butyl, iso-butyl, sec-butyl, tert-butyl, pentyl, hexyl, preferably methyl.

As used herein, the term "aryl" means a monovalent unsaturated
hydrocarbon ring system containing one or more aromatic or fluoro
10 containing rings per group, which may optionally be substituted on the one or more aromatic or fluoro containing rings, preferably with one or more (C₁-C₆)alkyl groups and which, in the case of two or more rings, may be fused rings, including, for example, phenyl, 2,4,6-trimethylphenyl, 2-isopropylmethylphenyl, 1-pentalenyl, naphthyl, anthryl, preferably phenyl.

As used herein, the term "aralkyl" means an aryl derivative of an alkyl
15 group, preferably a (C₂-C₆)alkyl group, wherein the alkyl portion of the aryl derivative may, optionally, be interrupted by an oxygen atom, such as, for example, phenylethyl, phenylpropyl, 2-(1-naphthyl)ethyl, preferably phenylpropyl, phenyloxypropyl, biphenyloxypropyl.

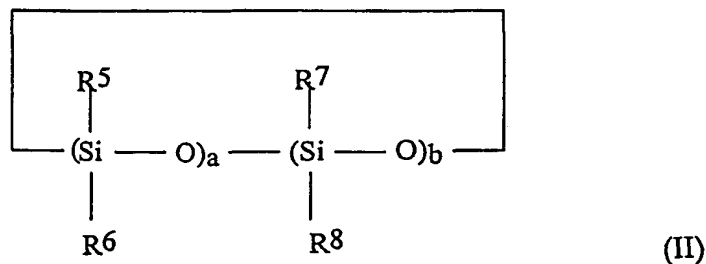
In a preferred embodiment, the linear or branched, volatile siloxane
20 comprises one or more of, hexamethyldisiloxane, octamethyltrisiloxane, decamethyltetrasiloxane, dodecamethylpentasiloxane, tetradecamethylhexasiloxane or hexadecamethylheptasiloxane or methyltris(trimethylsiloxy)silane. In a more highly preferred embodiment,
25 the linear or branched, volatile siloxane of the present invention comprises octamethyltrisiloxane, decamethyltetrasiloxane, or dodecamethylpentasiloxane or methyltris(trimethylsiloxy)silane. In a highly

preferred embodiment, the siloxane component of the composition of the present invention consists essentially of decamethyltetrasiloxane.

Suitable linear or branched volatile siloxanes are made by known methods, such as, for example, hydrolysis and condensation of one or more of tetrachlorosilane, methyltrichlorosilane, dimethyldichlorosilane, trimethylchlorosilane, or by isolation of the desired fraction of an equilibrate mixture of hexamethyldisiloxane and octamethylcyclotetrasiloxane or the like and are commercially available.

Compounds suitable as the cyclic siloxane component of the present invention are those containing a polysiloxane ring structure that includes from 2 to 20 silicon atoms in the ring. Preferably, the linear, volatile siloxanes and cyclic siloxanes are relatively volatile materials, having, for example, a boiling point of below about 300°C at a pressure of 760 millimeters of mercury ("mm Hg").

In a preferred embodiment, the cyclic siloxane component comprises one or more compounds of the structural formula (II):



wherein:

R⁵, R⁶, R⁷ and R⁸ are each independently a monovalent hydrocarbon group, preferably a (C₁-C₆)alkyl, more preferably, methyl; and a and b are each integers wherein 0 ≤ a ≤ 10 and 0 ≤ b ≤ 10, provided that 3 ≤ (a + b) ≤ 10.

In a preferred embodiment, the cyclic siloxane comprises one or more of, octamethylcyclotetrasiloxane, decamethylcyclopentasiloxane, dodecamethylcyclohexasiloxane, tetradecamethylcycloheptasiloxane. In a more highly preferred embodiment, the cyclic siloxane of the present invention comprises octamethylcyclotetrasiloxane or
5 decamethylcyclopentasiloxane. In a highly preferred embodiment, the cyclic siloxane component of the composition of the present invention consists essentially of decamethylcyclopentasiloxane.

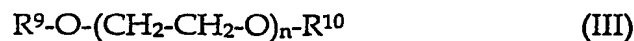
Suitable cyclic siloxanes are made by known methods, such as, for
10 example, hydrolysis and condensation of dimethyldichlorosilane and are commercially available.

The organic surfactants of the present invention comprise two or more surfactants selected from nonionic, cationic, anionic and amphoteric surfactants. The surfactants may comprise two or more surfactants selected
15 from the same or different classes.

Compounds suitable for use as the nonionic surfactant of the present invention are those that carry no discrete charge when dissolved in aqueous media. Nonionic surfactants are generally known in the art and include, for example, alkanol amides (such as, for example, coco, lauric, oleic and stearic
20 monoethanolamides, diethanolamides and monoisopropanolamides), amine oxides (such as, for example, polyoxyethylene ethanolamides and polyoxyethylene propanolamides), polyalkylene oxide block copolymers (such as, for example, poly(oxyethylene-co-oxypropylene)), ethoxylated
alcohols, (such as, for example, isostearyl polyoxyethylene alcohol, lauryl,
25 cetyl, stearyl, oleyl, tridecyl, trimethylnonyl, isodecyl, tridecyl), ethoxylated alkylphenols (such as, for example, nonylphenol), ethoxylated amines and ethoxylated amides, ethoxylated fatty acids, ethoxylated fatty esters and ethoxylated fatty oils (such as, for example, mono- and diesters of acids such

as lauric, isostearic, pelargonic, oleic, coco, stearic, and ricinoleic, and oils such as castor oil and tall oil), fatty esters, fluorocarbon containing materials, glycerol esters (such as, for example, glycerol monostearate, glycerol monolaurate, glycerol dilaurate, glycerol monoricinoleate, and glycerol oleate), glycol esters (such as, for example, propylene glycol monostearate, ethylene glycol monostearate, ethylene glycol distearate, diethylene glycol monolaurate, diethylene glycol monolaurate, diethylene glycol monooleate, and diethylene glycol stearate), lanolin-based surfactants, monoglycerides, phosphate esters, polysaccharide ethers, propoxylated fatty acids, propoxylated alcohols, and propoxylated alkylphenols, protein-based organic surfactants, sorbitan-based surfactants (such as, for example, sorbitan oleate, sorbitan monolaurate, and sorbitan palmitate), sucrose esters and glucose esters, and thio- and mercapto-based surfactants.

In a preferred embodiment, one component of the present invention comprises one or more nonionic surfactants according to one or more of the structural formulas III and IV:

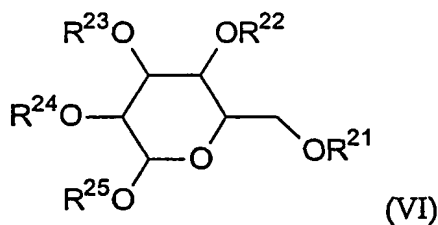
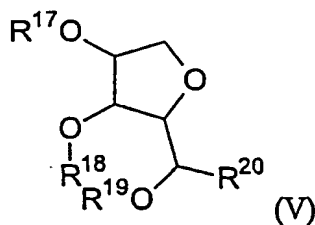


wherein:

R^9 is a monovalent hydrocarbon group of from 1 to 30 carbons that may be linear, cyclic, branched, unsaturated, aromatic or fluoro containing; R^{10} is hydrogen or a monovalent hydrocarbon group of 1 to 30 carbons that may be linear, cyclic, branched, unsaturated, aromatic or fluoro containing; and n is from about 1 to about 100, more preferably from about 1 to about 40. In a highly preferred embodiment, R^9 contains from 2 to about 24 carbons,

even more preferably from 8 to 24 carbons, R^{10} is H and n is from about 2 to about 20.

In another preferred embodiment, one component of the present invention comprises one or more nonionic surfactants that may be a sugar-based surfactant according to one or more of the structural formulas V and VI:

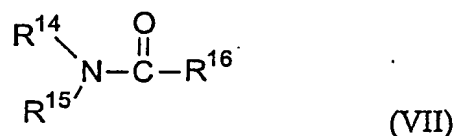


wherein:

each R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} and R^{25} is independently H or a monovalent hydrocarbon group of 1 to 30 carbons that may be linear, cyclic, branched, an oxygenated alkane or other chalcogen containing group. These surfactants may also be the open-chain analogs. In a preferred embodiment each R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} and R^{25} is independently H or a hydroxy-terminated polyoxyethylene of 1 to 10 repeat units, a monovalent hydrocarbon group of 1 to 4 carbons or a carboxyalkyl group of from 2 to 9 carbons. In another preferred embodiment, R^{17} , R^{20} and R^{21} are monovalent

hydrocarbon radicals of 8 to 20 carbons and R^{25} is $-\text{CH}_2-\text{OR}'$ with R' a hydrocarbon group of from 1 to 4 carbons.

In another preferred embodiment, one component of the present invention comprises one or more nonionic surfactants that may be an amine-
 5 based or phosphate ester-based surfactant according to one or more of the structural formulas VII and VIII:



wherein:

10 each R^{11} , R^{12} , R^{13} , R^{14} , R^{15} , and R^{16} is independently H or a monovalent hydrocarbon group of 1 to 30 carbons that may be linear, cyclic, branched, unsaturated, aromatic, fluoro containing, an oxygenated alkane or other chalcogen containing group. In a preferred embodiment, R^{11} , R^{12} , R^{14} and R^{15} are H or monovalent hydrocarbon radicals of 1 to 4 carbons and R^{13} and R^{16}
 15 are monovalent hydrocarbon radicals of 6 to 24 carbons. In another preferred embodiment, R^{11} , R^{12} , R^{14} and R^{15} are monovalent hydrocarbon radicals of 6 to 24 carbons and R^{13} and R^{16} are H or monovalent hydrocarbon radicals of 1 to 4 carbons.

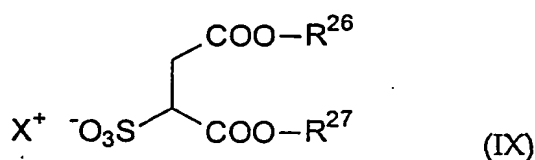
Compounds suitable for use as the anionic surfactant of the present
 20 invention are those having polar, solubilizing groups such as carboxylate, sulfonate, sulfate and phosphate. Anionic surfactants are generally known in the art and include, for example, alkyl aryl sulfonates (such as, for example,

alkylbenzenesulfonates), alkyl aryl sulfonic acids (such as, for example, sodium and ammonium salts of toluene-, xylene- and isopropylbenzenesulfonic acids), sulfonated amines and sulfonated amides (such as, for example, amidosulfonates), carboxylated alcohols and

5 carboxylated alkylphenol ethoxylates, diphenyl sulfonates, fatty esters, isethionates, lignin-based surfactants, olefin sulfonates (such as, for example, $RCH=CHSO_3Na$, where R is C_{10} - C_{16}), phosphorous-based surfactants, protein based surfactants, sarcosine-based surfactants (such as, for example, N-

10 acylsarcosinates such as sodium N-lauroylsarcosinate), sulfates and sulfonates of oils and/or fatty acids, sulfates and sulfonates of ethoxylated alkylphenols, sulfates of alcohols, sulfates of ethoxylated alcohols, sulfates of fatty esters, sulfates of aromatic or fluoro containing compounds, sulfosuccinamates, sulfosuccinates (such as, for example, diamyl-, dioctyl- and diisobutylsulfosuccinates), taurates, and sulfonic acids.

15 In a preferred embodiment, one component of the present invention comprises one or more anionic surfactants that may be a sulfosuccinate, sulfate, sulfonate, carboxylate, or phosphorous containing surfactant according to one or more of the structural formulas IX to XIII:



20





5 wherein:

each R^{26} , R^{27} , R^{28} , R^{29} and R^{30} is independently a monovalent hydrocarbon group of 1 to 30 carbons that may be linear, cyclic, branched, unsaturated, aromatic, fluoro containing, an oxygenated alkane or other chalcogen containing radical, and X is H or an alkali metal, alkaline earth element or a
10 chalcogen containing counterion or other suitable cation that does not unduly interfere with the functioning of the molecule as a surfactant where the subscript q is the valence or oxidation state of the cation X. In a preferred embodiment, R^{26} and R^{27} are each independently a linear, cyclic, or branched monovalent hydrocarbon group of 4 to 20 carbons, more preferably a linear, cyclic, or branched monovalent hydrocarbon group of 6 to 13 carbons; R^{28} is a
15 monovalent hydrocarbon group of 4 to 20 carbons, more preferably from 8 to 16 carbons; R^{29} is monovalent hydrocarbon group of 8 to 26 carbons, more preferably from 10 to 20 carbons; and R^{30} is monovalent hydrocarbon group of 8 to 30 carbons.

20 Compounds suitable for use as the cationic surfactant of the present invention are those having a positive charge when dissolved in aqueous media, which resides on an amino or quaternary nitrogen. Cationic surfactants are generally known in the art and include, for example, amine acetates, amines (such as, for example, oxygen-free amines such as
25 monoalkylamines, dialkylamines and N-alkyltrimethylene diamines, and oxygen-containing amines such as amine oxides, ethoxylated alkylamines, 1-

(2-hydroxyethyl)-2-imidazolines, and alkoxylates of ethylenediamine), and quaternary ammonium salts (such as, for example, dialkyldimethylammonium salts, alkylbenzyltrimethylammonium chlorides, alkyltrimethylammonium salts and alkylpyridium halides), and quaternary ammonium esters (such as, for example, diethyl ester dimethyl ammonium chloride).

In a preferred embodiment, one component of the present invention comprises one or more cationic surfactants that may be a quaternary amine-based surfactant according to the structural formula XIV

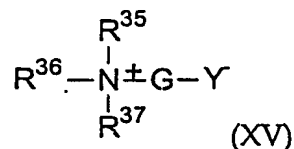


wherein:

each R^{31} , R^{32} , R^{33} , and R^{34} is independently H or a monovalent hydrocarbon group of 1 to 30 carbons that may be linear, cyclic, branched, unsaturated, aromatic, fluoro containing, an oxygenated alkane or other chalcogen containing group, and J is a suitable anion having an oxidation state or valence p that does not unduly interfere with the functioning of the molecule as a surfactant. In a preferred embodiment, R^{31} and R^{32} are each independently a monovalent hydrocarbon radical of 1 to 4 carbons and R^{33} and R^{34} are each independently a monovalent hydrocarbon radical of 8 to 24 carbons.

Compounds suitable for use as the amphoteric surfactant of the present invention are those containing both an acidic and basic hydrophilic group. Amphoteric surfactants are compatible with anionic and cationic surfactants. Amphoteric surfactants are generally known in the art and include, for example, betaine derivatives such as alkylbetaines and amidopropylbetaines, block copolymers, imidazolines and lecithins.

In a preferred embodiment, one component of the present invention comprises one or more amphoteric surfactants according to the structural formula XV:



5 wherein:

each R^{35} , R^{36} and R^{37} is independently H or a monovalent hydrocarbon group of 1 to 30 carbons that may be linear, cyclic, branched, unsaturated, aromatic, fluoro containing, an oxygenated alkane or other chalcogen containing group, G is a divalent spacer group, Y is a carboxylate, sulfonate, sulfate, phosphonate or other similar group. In a preferred embodiment, R^{35} is a monovalent hydrocarbon group of 1 to 4 carbons, more preferably methyl, and R^{36} and R^{37} are each independently monovalent hydrocarbon group of 6 to 24 carbons.

15 Surfactants are known in the art and are commercially available under many trade names from many sources, such as for example, Akzo Chemical Co., Calgene Chemical Inc., Emkay Chemical Co., Hercules, Inc., ICI Americas Inc., Lonza, Inc., Rhone Poulenc, Inc., Union Carbide Corp. and Witco Corp.

20 Generally the compositions of the present invention comprise two or more surfactants selected from the group consisting of anionic, nonionic, cationic and amphoteric surfactants. In one preferred embodiment, the composition of the present invention comprises two or more anionic surfactants, or two or more cationic surfactants, or two or more nonionic surfactants or two or more amphoteric surfactants, preferably two or more anionic surfactants or two or more nonionic surfactants. In another preferred

embodiment, the composition of the present invention comprises a sulfosuccinate surfactant and a sulfonic acid surfactant, more preferably sulfosuccinate and dodecylbenzenesulfonic acid, or a sulfated anionic surfactant and a sulfosuccinate, or a sulfated anionic surfactant and a sulfonic acid surfactant, more preferably sulfosuccinate and dodecylbenzenesulfonic acid, or a nonionic polymeric surfactant and an ethoxylated alcohol.

In another preferred embodiment, the composition of the present invention comprises at least two surfactants selected from anionic, nonionic, cationic and amphoteric surfactants, provided that at least two of the surfactants are selected from two different members of the group of surfactants, such that there is at least one anionic surfactant and at least one cationic surfactant, or at least one anionic surfactant and at least one nonionic surfactant, or at least one nonionic surfactant and at least one cationic surfactant, or at least one anionic surfactant and at least one amphoteric surfactant, or at least one amphoteric surfactant and at least one cationic surfactant or at least one nonionic surfactant and at least one amphoteric surfactant. In a highly preferred embodiment, the composition of the present invention comprises a sulfocccinate and a quaternary ammonium salt, or a sulfated anionic surfactant and an ethoxylated alcohol, or a sulfonic acid, more preferably dodecylbenzenesulfonic acid, and a nonionic polymeric surfactant, or a sulfosuccinate and a nonionic polymeric surfactant, or a sulfonic acid, more preferably dodecylbenzenesulfonic acid, and an ethoxylated alcohol, or a sulfonic acid, more preferably dodecylbenzenesulfonic acid, and a quaternary ammonium salt, or a sulfated anionic surfactant and a quaternary ammonium salt, or a sulfated anionic surfactant and a nonionic polymeric surfactant, or a sulfated anionic surfactant and an ethoxylated alcohol, or a sulfated anionic surfactant and a quaternary ammonium salt, or an ethoxylated alcohol and a quaternary ammonium salt, or a sulfosuccinate, a sulfated anionic surfactant and two

different ethoxylated alcohols, or a sulfosuccinate, a sulfated anionic surfactant and a quaternary ammonium salt.

In another preferred embodiment, the composition of the present invention comprises at least three surfactants selected from the group consisting of anionic, nonionic, cationic and amphoteric surfactants. Preferably these surfactants may be chosen wherein each of the three surfactants are selected from different surfactants in terms of anionic, nonionic, cationic or amphoteric, for example is at least one anionic surfactant, at least one cationic surfactant and at least one nonionic surfactant, or at least one anionic surfactant, at least one cationic surfactant and at least one amphoteric surfactant, or at least one cationic surfactant, at least one nonionic surfactant and at least one amphoteric surfactant. In a highly preferred embodiment, the composition of the present invention comprises a sulfosuccinate, a sulfated anionic surfactant, two different ethoxylated alcohols, and a quaternary ammonium salt, or a sulfated anionic surfactant, an ethoxylated alcohol and a quaternary ammonium salt.

In another preferred embodiment, the composition of the present invention comprises at least four surfactants selected from the group of anionic, nonionic, cationic and amphoteric surfactants, provided that at least one surfactant is selected from each member of the group of surfactants, such that there is at least one anionic surfactant, at least one cationic surfactant, at least one nonionic surfactant and at least one amphoteric surfactant.

The dry cleaning composition of the present invention is made by adding to the siloxane fluid two or more surfactants and mixing to form a homogeneous solution. The surfactants may be mixed together before addition to the siloxane, or they may added to the siloxane individually.

In a preferred embodiment, the dry cleaning composition of the present invention further comprises a minor amount, preferably, less than 50 pbw per 100 pbw of the composition, more preferably, less than 10 pbw per 100 pbw of the composition, of one or more non-siloxane fluids. Suitable non-siloxane fluids include aqueous fluids, such as, for example, water, and organic fluids, for example, hydrocarbon fluids and halogenated hydrocarbon fluids.

According to the process of the present invention, an article, such as for example, a textile or leather article, typically, a garment, is dry cleaned by contacting the article with the composition of the present invention. In a preferred embodiment, the articles to be cleaned include textiles made from natural fibers, such as for example, cotton, wool, linen and hemp, from synthetic fibers, such as, for example, polyester fibers, polyamide fibers, polypropylene fibers and elastomeric fibers, from blends of natural and synthetic fibers, from natural or synthetic leather or natural or synthetic fur.

The article and dry cleaning composition are then separated, by, for example, one or more of draining and centrifugation. In a preferred embodiment, separation of the article and dry cleaning composition is followed by the application of heat, preferably, heating to a temperature of from 15°C to 120°C, preferably from 20°C to 100°C, or reduced pressure, preferably, a pressure of from 1 mm Hg to 750 mm Hg, or by application of both heat and reduced pressure, to the article.

The surfactant components of the dry cleaning composition are typically depleted through use in the cleaning cycle. Some of the surfactants remain on the articles being cleaned. To promote efficient cleaning of articles, the dry cleaning solvent is periodically cleaned or refreshed, preferably distilled, to remove the dirt that has been removed from the articles being

cleaned. Once the solvent has been cleaned, additional surfactants are typically added to the cleaned solvent to replenish the amount of surfactants in the solvent. This process is repeated periodically, depending on the number of uses and the amount of soil on articles being cleaned, so that the solvent will effectively clean and remove soil from articles, and each time, additional surfactants are added to the solvent.

In another preferred embodiment, the concentrate composition of the present invention is added to the dry cleaning composition to replenish the surfactants that have been depleted.

The concentrate composition of the present invention can be made in any of the combinations of organic disclosed above, such as, for example, a concentrate composition comprising at least one anionic surfactant and at least one cationic surfactant, or at least two anionic surfactants. The concentrate composition may optionally further comprise a siloxane fluid. In a highly preferred embodiment, the concentrate composition of the present invention comprises at least one anionic surfactant and at least one nonionic surfactant, and optionally, a siloxane fluid. The concentrate composition may optionally further comprise additional components known in the art, such as, for example, brighteners, softeners, water, fragrances and the like.

The concentrate composition of the present invention is made by adding together two or more surfactants in desired amounts, and optionally, a siloxane fluid, and stirring to form a homogeneous solution. The concentrate may then be added to a siloxane fluid to form a dry cleaning fluid at any time, such as before the initial cleaning, or after the fluid has been used to replenish the amount of surfactant in the cleaning fluid. The surfactant level in the cleaning fluid is depleted through routine use and cleaning.

Testing for water soluble stain removal was accomplished using fabric swatches supplied by the International Fabricare Institute ("IFI") (Silver Spring, MD) that contained a water soluble dye. The color change of a swatch of this material was measured by a Minolta CR-300[®] Colorimeter using the Hunter Color Number difference calculations. The larger the change in Hunter Color Number (ΔE), the greater the dye removal and the more efficient the cleaning.

The following examples are to illustrate the invention and are not to be construed as limiting the claims.

EXAMPLES

Testing procedure: Circular swatches (from IFI) containing a water soluble dye were measured by the colorimeter, and the initial color values for L, a and b (as defined by the Hunter Color Numbers) were recorded. The fabric swatches were then placed in vials containing the cleaning composition of the present invention, and the vial was shaken for 10 minutes at ambient temperature. The fabric swatch was removed and allowed to drip dry for 2 to 5 seconds, then placed on absorbent toweling and allowed to air dry for 16 to 24 hours. A second reading of each fabric swatch was taken and the color difference (ΔE) was determined using the following formula:

$$\Delta E = [(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2]^{1/2}$$

This color difference represents the relative amount of cleaning, with the higher ΔE indicative of better cleaning performance.

Surfactants used in the Examples

Surfactant	Type of Surfactant
A	Aerosol OT* (anionic sulfosuccinate surfactant)
B	Aerosol GPG* (anionic sulfosuccinate surfactant)
C	Aerosol TR* (anionic sulfosuccinate surfactant)
D	DDBSA (dodecylbenzenesulfonic acid - anionic surfactant)
E	Glucopon™ 425** (nonionic polymeric surfactant)
F	Anionic surfactant - R-SO ₄ -Na ⁺ where R is C ₁₄ -C ₁₆ alkene
G	Anionic surfactant - R-PhO-(EO) ₃ -OSO ₃ -Na ⁺ where R is C ₁₂
H	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O) ₉ H where R is C ₁₂ -C ₁₃)
I	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O) ₇ H where R is C ₁₄ -C ₁₅)
J	Quaternary Ammonium Salt (R ₂ R'MeN ⁺ Cl ⁻ where R' is alkyl, R is polyether)
K	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O)H where R is C ₄)
L	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O) ₂ H where R is C ₄)
M	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O) ₃ H where R is C ₁₂ -C ₁₅)
N	AtPhos 3250
O	AtPhos 3226
P	Yelkin TS (Lecithin)
Q	Ultralec F (Lecithin)
R	1,2-hexanediol
S	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O) ₂ H where R is ethylhexyl)
T	1,2-butanediol
U	1,2-decanediol
V	Didecyldimethylammonium bromide
W	Cetyltrimethyl ammonium bromide
X	1,6-hexanediol
Y	1,10-decanediol
Z	Dihexadecyldimethyl ammonium bromide
AA	BET-C30 (amphoteric)
BB	JC HA (amphoteric)
CC	Ethoxylated Alcohol (R-O-(CH ₂ CH ₂ O) ₂ H where R is C ₆)
DD	Fluorad FC135
EE	Fluorad FC430

*Commercially available from Cytek Industries

**Commercially available from Henkel Canada Ltd.

A cleaning composition according to the present invention containing a cyclic siloxane (D₅) and a mixture of two surfactants from different surfactant classes was made. Fabric swatches were cleaned using the above procedure, and the color difference was measured to determine the effectiveness of the
5 cleaning composition. A solution of cyclic siloxane (D₅) without a surfactant was used as a control. Results are shown in Table 1 below.

Table 1 - Binary Mixtures of Surfactants in D5

Exp.	D ₅	Surf. 1	Amt (g)	Surf. 2	Amt (g)	Delta E	Good Cleaning	Enhanced Cleaning
Control	Control	-	-	-	-	1.9	-	
1	14.7	A	0.15	D	0.15	43.7	X	
2	14.25	A	0.15	D	0.6	46.7	X	
3	14.25	A	0.6	D	0.15	18.3	X	
4	14.7	A	0.15	F	0.15	2.9	X	
5	14.25	A	0.15	F	0.6	11.7	X	
6	14.25	A	0.6	F	0.15	6.4	X	
7	14.7	A	0.15	G	0.15	5.5	X	
8	14.25	A	0.15	G	0.6	18.7	X	X
9	14.25	A	0.6	G	0.15	10.8	X	X
10	14.7	A	0.15	H	0.15	15.4	X	
11	14.25	A	0.15	H	0.6	22.6	X	
12	14.25	A	0.6	H	0.15	10.0	X	
13	14.7	A	0.15	I	0.15	22.6	X	
14	14.25	A	0.15	I	0.6	7.8	X	
15	14.25	A	0.6	I	0.15	22.2	X	
16	14.7	A	0.15	J	0.15	14.0	X	
17	14.25	A	0.15	J	0.6	11.8	X	
18	14.25	A	0.6	J	0.15	23.1	X	X
19	14.7	A	0.15	E	0.15	17.5	X	X
20	14.25	A	0.15	E	0.6	3.8	X	
21	14.25	A	0.6	E	0.15	30.2	X	X
22	14.7	A	0.15	N	0.15	14.3	X	
23	14.7	A	0.15	O	0.15	12.2	X	
24	14.7	A	0.15	P	0.15	6.7	X	
25	14.7	A	0.15	Q	0.15	3.0	X	
26	14.25	A	0.60	R	0.15	2.5	X	
27	14.25	A	0.15	R	0.60	4.1	X	
28	14.7	A	0.15	R	0.15	10.5	X	
29	14.7	A	0.15	S	0.15	3.8	X	
30	14.7	A	0.15	T	0.15	20.8	X	
31	14.7	A	0.15	U	0.15	9.0	X	
32	14.25	B	0.6	R	0.15	3.2	X	
33	14.25	B	0.15	R	0.60	14.3	X	
34	14.7	B	0.15	R	0.15	22.6	X	X
35	14.7	B	0.15	S	0.15	0.7		
36	14.7	B	0.15	T	0.15	6.5	X	
37	14.7	B	0.15	U	0.15	2.8	X	
38	14.25	C	0.6	R	0.15	1.8		
39	14.25	C	0.15	R	0.60	3.9	X	
40	14.7	C	0.15	R	0.15	24.5	X	X
41	14.7	C	0.15	S	0.15	1.2		
42	14.7	C	0.15	T	0.15	24.1	X	
43	14.7	C	0.15	U	0.15	4.0	X	
44	14.7	D	0.15	F	0.15	26.7	X	

45	14.25	D	0.15	F	0.6	46.4	X	X
46	14.25	D	0.6	F	0.15	44.4	X	
47	14.7	D	0.15	G	0.15	38.7	X	
48	14.25	D	0.15	G	0.6	48.5	X	X
49	14.25	D	0.6	G	0.15	41.2	X	
50	14.7	D	0.15	H	0.15	38.9	X	
51	14.25	D	0.15	H	0.6	46.7	X	
52	14.25	D	0.6	H	0.15	45.6	X	
53	14.7	D	0.15	I	0.15	35.3	X	
54	14.25	D	0.15	I	0.6	45.5	X	
55	14.25	D	0.6	I	0.15	33.6	X	
56	14.7	D	0.15	J	0.15	13.7	X	
57	14.25	D	0.15	J	0.6	35.8	X	
58	14.25	D	0.6	J	0.15	42.1	X	
59	14.7	D	0.15	E	0.15	38.7	X	
60	14.25	D	0.15	E	0.6	43.0	X	X
61	14.25	D	0.6	E	0.15	2.7	X	
62	14.85	D	0.015	I	0.135	27.8	X	
63	14.85	D	0.015	V	0.135	10.3	X	
64	14.25	E	0.60	R	0.15	12.0	X	
65	14.25	E	0.15	R	0.60	25.6	X	
66	14.7	E	0.15	R	0.15	28.6	X	X
67	14.7	F	0.15	H	0.15	11.6	X	
68	14.25	F	0.15	H	0.6	4.8	X	
69	14.25	F	0.6	H	0.15	19.0	X	X
70	14.7	F	0.15	I	0.15	29.7	X	X
71	14.25	F	0.15	I	0.6	3.0	X	
72	14.25	F	0.6	I	0.15	19.9	X	
73	14.7	F	0.15	J	0.15	25.3	X	
74	14.25	F	0.15	J	0.6	11.2	X	
75	14.25	F	0.6	J	0.15	8.6	X	
76	14.7	F	0.15	E	0.15	8.1	X	
78	14.25	F	0.15	E	0.6	20.3	X	X
79	14.25	F	0.6	E	0.15	32.5	X	X
80	14.85	F	0.075	R	0.075	17.8	X	X
81	14.85	F	0.075	U	0.075	7.0	X	
82	14.7	G	0.15	H	0.15	31.4	X	
83	14.25	G	0.15	H	0.6	10.3	X	
84	14.25	G	0.6	H	0.15	6.6	X	
85	14.7	G	0.15	I	0.15	28.2	X	X
86	14.25	G	0.15	I	0.6	2.4	X	
87	14.25	G	0.6	I	0.15	24.1	X	X
88	14.7	G	0.15	J	0.15	25.4	X	
89	14.25	G	0.15	J	0.6	25.3	X	
90	14.25	G	0.6	J	0.15	10.8	X	
91	14.7	G	0.15	E	0.15	14.7	X	X
92	14.25	G	0.15	E	0.6	5.3	X	
93	14.25	G	0.6	E	0.15	26.7	X	X
94	14.85	G	0.075	R	0.075	7.8	X	
95	14.85	G	0.075	U	0.075	17.4	X	X

96	14.7	H	0.15	J	0.15	35.7	X	
97	14.25	H	0.15	J	0.6	35.1	X	
98	14.25	H	0.6	J	0.15	10.7	X	
99	14.7	H	0.15	E	0.15	18.5	X	
100	14.25	H	0.15	E	0.6	33.2	X	
101	14.25	H	0.6	E	0.15	26.1	X	
102	14.7	I	0.15	J	0.15	35.0	X	
103	14.25	I	0.15	J	0.6	34.8	X	
104	14.25	I	0.6	J	0.15	7.2	X	
105	14.7	I	0.15	E	0.15	5.7	X	
106	14.25	I	0.15	E	0.6	2.9	X	
107	14.25	I	0.6	E	0.15	22.7	X	
108	14.7	W	0.15	M	0.15	27.4	X	
109	14.7	W	0.15	R	0.15	24.8	X	X
110	14.7	W	0.15	X	0.15	7.7	X	
111	14.7	W	0.15	T	0.15	17.3	X	
112	14.7	W	0.15	U	0.15	3.9	X	
113	14.7	W	0.15	Y	0.15	4.2	X	
114	14.85	W	0.075	E	0.075	1.8		
115	14.85	W	0.015	E	0.135	6.1	X	
116	14.85	W	0.075	I	0.075	32.1	X	X
117	14.85	W	0.015	I	0.135	4.8	X	
118	14.85	W	0.015	F	0.135	1.8		
119	14.85	W	0.135	F	0.015	2.2	X	
120	14.85	W	0.015	G	0.135	13.1	X	X
121	14.85	W	0.135	G	0.015	1.2		
122	14.7	V	0.15	M	0.15	19.7	X	
123	14.7	V	0.15	R	0.15	10.1	X	
124	14.7	V	0.15	X	0.15	7.3	X	
125	14.7	V	0.15	T	0.15	11.3	X	
126	14.7	V	0.15	U	0.15	23.0	X	X
127	14.7	V	0.15	Y	0.15	19.8	X	X
128	14.85	V	0.075	E	0.075	18.2	X	X
129	14.85	V	0.015	E	0.135	7.2	X	X
130	14.85	V	0.075	I	0.075	23.2	X	X
131	14.85	V	0.015	I	0.135	25.5	X	X
132	14.85	V	0.015	F	0.135	8.9	X	
133	14.85	V	0.135	F	0.015	29.3	X	X
134	14.85	V	0.015	G	0.135	17.1	X	X
135	14.85	V	0.135	G	0.015	37.8	X	X
136	14.7	Z	0.15	M	0.15	25.3	X	X
137	14.7	Z	0.15	R	0.15	26.2	X	X
138	14.7	Z	0.15	X	0.15	20.1	X	
139	14.7	Z	0.15	T	0.15	3.8	X	
140	14.7	Z	0.15	U	0.15	2.2	X	
141	14.7	Z	0.15	Y	0.15	1.5		
142	14.25	AA	0.6	R	0.15	6.4	X	
143	14.25	AA	0.15	R	0.6	25.7	X	
144	14.7	AA	0.15	R	0.15	15.5	X	
145	14.25	AA	0.6	E	0.15	17.8	X	X

146	14.25	AA	0.15	E	0.6	36.7	X	X
147	14.7	AA	0.15	E	0.15	9.7	X	
148	14.25	BB	0.6	R	0.15	31.6	X	X
149	14.25	BB	0.15	R	0.6	30.3	X	X
150	14.7	BB	0.15	R	0.15	34.9	X	X
151	14.25	BB	0.6	E	0.15	34.1	X	
152	14.25	BB	0.15	E	0.6	32.7	X	X
153	14.7	BB	0.15	E	0.15	29.3	X	X
154	14.25	R	0.6	I	0.15	2.0		
155	14.25	R	0.15	I	0.6	28.0	X	
156	14.7	R	0.15	I	0.15	8.1	X	
157	14.7	S	0.15	I	0.15	8.2	X	
158	14.7	S	0.15	M	0.15	17.7	X	
159	14.7	CC	0.15	I	0.15	7.0	X	
160	14.7	CC	0.15	M	0.15	2.3	X	
161	14.85	DD	0.015	A	0.135	1.5		
162	14.85	EE	0.015	A	0.135	9.7	X	X

As shown in Table 1, almost all the binary mixtures exhibited good cleaning when compared to the control. The synergistic relationship exhibited by some of the mixtures of different surfactant classes was highly unexpected and is denoted in the column labeled enhanced cleaning. Results were considered unexpected when a ΔE value greater the average of the two single surfactant ΔE values resulted from an experiment. Such unexpected results are noted with a mark in all the columns, *infra*, entitled "enhanced cleaning."

Table 2 shows the results of using a mixture of two different surfactants from different surfactant classes in a linear volatile siloxane. A solution of MD₂M was used as a control.

Table 2 - Binary Mixtures of Surfactants in MD2M

Run	MD2M	Surfactant	amt	Surf 2	amt	delta E	Good Cleaning	Enhanced Cleaning
163	14.85	A	0.075	E	0.075	18.6	X	X
164	14.85	C	0.075	R	0.075	30.5	X	X
165	14.85	F	0.075	I	0.075	12.6	X	
166	14.85	G	0.075	I	0.075	17.0	X	X
167	14.85	G	0.075	E	0.075	5.7	X	
168	14.85	Z	0.075	R	0.075	24.0	X	X
169	14.85	E	0.075	R	0.075	12.7	X	
170	14.85	BB	0.075	E	0.075	43.8	X	
171	14.85	BB	0.075	R	0.075	54.8	X	
172	14.25	A	0.6	G	0.15	12.5	X	X
173	14.7	A	0.15	E	0.15	19.3	X	
174	14.25	A	0.6	J	0.15	25.5	X	X
175	14.7	C	0.15	R	0.15	10.0	X	
176	14.25	D	0.15	F	0.6	54.5	X	
177	14.25	D	0.15	G	0.6	34.3	X	
178	14.25	D	0.15	E	0.6	40.6	X	
179	14.7	F	0.15	I	0.15	14.5	X	
180	14.25	F	0.6	E	0.15	9.4	X	
181	14.7	G	0.15	I	0.15	37.4	X	
182	14.7	G	0.15	E	0.15	16.5	X	
183	14.7	Z	0.15	R	0.15	35.4	X	
184	14.85	V	0.075	E	0.075	27.2	X	X
185	14.85	V	0.075	I	0.075	26.5	X	X
186	14.85	F	0.075	R	0.075	13.5	X	
187	14.7	E	0.15	R	0.15	25.3	X	
188	14.7	BB	0.15	E	0.15	49.2	X	
189	14.7	BB	0.15	R	0.15	46.1	X	
control	15	-	-	-	-	1.9	X	

Table 2 shows good cleaning behavior in linear siloxane solvent. Several binary compositions exhibited enhanced (unexpected results) cleaning characteristics.

A cleaning composition according to the present invention containing a cyclic siloxane (D₅) and a mixture of three or more surfactants from different surfactant classes was made. Fabric swatches were cleaned using the above procedure, and the color difference was measured to determine the effectiveness of the cleaning composition. A solution of cyclic siloxane (D₅) without a surfactant was used as a control.

Table 3 - Mixtures of Three or More Surfactants

Exp #	D5 pbw	Surf 1	Amt pbw	Surf 2	Amt pbw	Surf 3	Amt pbw	Water	ΔE
190	99	A	0.45	R	0.45	V	0.1	-	22.6
191	95	A	2.25	R	2.25	V	0.5	-	11.9
192	98	A	0.45	R	0.45	V	0.1	1	13.7
193	99	A	0.45	R	0.45	I	0.1	-	14.1
194	95	A	2.25	R	2.25	I	0.5	-	10.5
195	98	A	0.45	R	0.45	I	0.1	1	3.1
196	99	A	0.45	R	0.45	E	0.1	-	28.3
197	95	A	2.25	R	2.25	E	0.5	-	5.6
198	98	A	0.45	R	0.45	E	0.1	1	16.4
199	99	F	0.1	R	0.45	I	0.1	-	20.4
200	95	F	0.5	R	2.25	I	2.25	-	14.1
201	98	F	0.1	R	0.45	I	0.1	1	15.7
202	99	E	0.45	I	0.45	R	0.1	-	9.4
203	95	E	2.45	I	2.45	R	0.1	-	4.3
204	98	E	0.45	I	0.45	R	0.1	1	12.9
205	99	E	0.45	I	0.45	V	0.1	-	7.9
206	95	E	2.45	I	2.45	V	0.1	-	13.1
207	98	E	0.45	I	0.45	V	0.1	1	5.4
208	99	E	0.45	I	0.45	F	0.1	-	17.5
209	95	E	2.45	I	2.45	F	0.1	-	2.5
210	98	E	0.45	I	0.45	F	0.1	1	2.6

Table 3 shows that good cleaning can be obtained from mixtures of three organic surfactants with water optionally present.

Table 4. Higher Order Mixtures

Run	D ₅	Surf. 1	Amt (g)	Surf. 2	Amt (g)	Surf. 3	Amt (g)	Surf. 4	Amt (g)	Surf. 5	Amt (g)	Delta E
1	14.34	B	0.35	F	0.11	K	0.05	J	0.11	M	0.05	25.2
2	14.25	B	0.1	F	0.15	-	-	J	0.5	-	-	34.1
3	14.25	A	0.1	F	0.15	-	-	J	0.5	-	-	35.9
4	14.25	C	0.1	F	0.15	-	-	J	0.5	-	-	34.6
5	14.25	-	-	F	0.15	L	0.1	J	0.5	-	-	39.1
6	14.34	C	0.35	F	0.11	K	0.05	J	0.11	H	0.05	14.7
7	14.34	B	0.35	F	0.11	L	0.05	J	0.11	H	0.05	12.6
8	14.34	A	0.05	F	0.11	K	0.35	J	0.11	H	0.05	24.6
9	14.25	B	0.1	F	0.15	-	-	J	0.5	-	-	36.8
10	14.34	C	0.35	F	0.11	L	0.05	J	0.11	M	0.05	20.9
11	14.25	B	0.30	F	0.15	K	0.15	-	-	I	0.15	13.3

Table 4 shows cleaning benefits derived from a multiple combination of organic surfactants.

Concentrates of surfactants were also made as exemplified by the following 2 examples.

Concentrate 1 : 4 parts surfactant B, 2 parts, surfactant E, 2 parts surfactant K and 2 parts surfactant I were added together in an appropriate
5 container and stirred to form a homogeneous solution.

Concentrate 2 : 2 parts surfactant E, 2 parts, surfactant A; and 2 parts surfactant R were added together in an appropriate container and stirred to form a homogeneous solution.

The present invention exhibits improved performance of dry cleaning
10 agents for stain removal, particularly water soluble stains, through the addition of a mixture of different classes of surfactants, and optionally, water.

CLAIMS: Having described the invention that which is claimed is:

1. A dry cleaning composition, comprising a volatile cyclic, linear or branched siloxane, or mixture thereof, and two or more organic surfactants.
- 5 2. The composition of Claim 1, comprising from about 90 to about 99.99 parts by weight of the volatile siloxane and from about 0.001 to less than 10 parts by weight of the surfactants.
3. The composition of Claim 2, further comprising from about 0.01 to about 15 parts by weight of water.
- 10 4. The composition of Claim 1, wherein the surfactants are selected from the classes of nonionic, cationic, anionic and amphoteric surfactants.
5. The composition of Claim 1, further comprising a silicone surfactant or mixture of silicone surfactants.
6. The composition of Claim 1, comprising two or more nonionic
15 surfactants.
7. The composition Claim 1, comprising two or more cationic surfactants.
8. The composition of Claim 1, comprising two or more anionic surfactants.
- 20 9. The composition of Claim 1 comprising two or more amphoteric surfatctants.
10. The composition of Claim 6, further comprising a silicone surfactant or mixture of silicone surfactants.

11. The composition of Claim 7, further comprising a silicone surfactant or mixture of silicone surfactants.

12. The composition of Claim 8, further comprising a silicone surfactant or mixture of silicone surfactants.

5 13. The composition of Claim 9, further comprising a silicone surfactant or mixture of silicone surfactants.

14. A dry cleaning composition, comprising a volatile cyclic, linear or branched siloxane, or mixture thereof, and three or more organic surfactants.

10 15. The composition of Claim 14, comprising from about 90 to about 99.99 parts by weight of the volatile siloxane and from about 0.001 to less than 10 parts by weight of the surfactants.

16. The composition of Claim 15, further comprising from about 0.01 to about 15 parts by weight of water.

15 17. The composition of Claim 14, wherein the surfactants are selected from the classes of nonionic, cationic, anionic and amphoteric surfactants.

18. The composition of Claim 14, further comprising a silicone surfactant or mixture of silicone surfactants.

20 19. The composition of Claim 14, comprising two or more nonionic surfactants.

20. The composition Claim 14, comprising two or more cationic surfactants.

21. The composition of Claim 14, comprising two or more anionic surfactants.

22. The composition of Claim 14 comprising two or more amphoteric surfatctants.

5 23. The composition of Claim 19, further comprising a silicone surfactant or mixture of silicone surfactants.

24. The composition of Claim 20, further comprising a silicone surfactant or mixture of silicone surfactants.

10 25. The composition of Claim 21, further comprising a silicone surfactant or mixture of silicone surfactants.

26. The composition of Claim 22, further comprising a silicone surfactant or mixture of silicone surfactants.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/26665

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 D06L1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D06L C11D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 063 135 A (BERNDT DIETER R ET AL) 16 May 2000 (2000-05-16) column 6, line 44 -column 7, line 67 ---	1,4-6, 10,14, 17-19,23
X A	DE 37 39 711 A (KREUSSLER CHEM FAB) 8 June 1989 (1989-06-08) page 3, line 1 - line 7; example 2 ---	1-4 6-8, 14-17, 19-21
X	EP 1 043 443 A (GEN ELECTRIC) 11 October 2000 (2000-10-11) page 4, line 2 - line 47; claims 8-10; example 3 --- -/--	1-26

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- *G* document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Int nal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 041 189 A (GEN ELECTRIC) 4 October 2000 (2000-10-04) page 3, line 15 -page 4, line 10; claim 1; example 2	1-26
X	EP 0 458 969 A (TOKYO SHIBAURA ELECTRIC CO) 4 December 1991 (1991-12-04) page 8, line 9 - line 23; examples 3-5	1,4,8 2,3,6,7, 9,14-17, 19-22

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/26665

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6063135	A	16-05-2000	US 5942007 A	24-08-1999
			US 5865852 A	02-02-1999
			AU 4993599 A	07-02-2000
			AU 5101799 A	07-02-2000
			BR 9912088 A	10-04-2001
			BR 9912811 A	02-05-2001
			CN 1309733 T	22-08-2001
			CN 1309734 T	22-08-2001
			EP 1084289 A1	21-03-2001
			EP 1092056 A1	18-04-2001
			HU 0102648 A2	28-12-2001
			NO 20010231 A	14-03-2001
			NO 20010232 A	14-03-2001
			WO 0004221 A1	27-01-2000
			WO 0004222 A1	27-01-2000
			US 6042617 A	28-03-2000
			US 6056789 A	02-05-2000
			US 6042618 A	28-03-2000
			US 6086635 A	11-07-2000
			US 6059845 A	09-05-2000
DE 3739711	A	08-06-1989	DE 3739711 A1	08-06-1989
EP 1043443	A	11-10-2000	US 6310029 B1	30-10-2001
			EP 1043443 A1	11-10-2000
			JP 2000313900 A	14-11-2000
			US 2001034912 A1	01-11-2001
EP 1041189	A	04-10-2000	EP 1041189 A1	04-10-2000
			JP 2000319694 A	21-11-2000
EP 0458969	A	04-12-1991	DE 69031030 D1	14-08-1997
			DE 69031030 T2	11-12-1997
			EP 0458969 A1	04-12-1991
			KR 9307226 B1	04-08-1993
			RU 2104331 C1	10-02-1998
			US 5977040 A	02-11-1999
			US 6136766 A	24-10-2000
			US 5443747 A	22-08-1995
			CA 2034488 A1	27-04-1991
			CA 2151846 A1	27-04-1991
			CA 2151847 A1	27-04-1991
			CA 2151848 A1	27-04-1991
			CA 2151849 A1	27-04-1991
			CN 1095410 A ,B	23-11-1994
			CN 1103113 A ,B	31-05-1995
			EP 0673995 A2	27-09-1995
			EP 0673996 A2	27-09-1995
			HK 1001094 A1	22-05-1998
			JP 2963406 B2	18-10-1999
			JP 9176697 A	08-07-1997
			JP 2752352 B2	18-05-1998
			JP 9188897 A	22-07-1997
			WO 9106621 A1	16-05-1991
			JP 2949201 B2	13-09-1999
			JP 7216569 A	15-08-1995
			JP 2656450 B2	24-09-1997
			JP 7216387 A	15-08-1995

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/26665

Information on patent family members

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0458969	A	SG 47816 A1	17-04-1998
		SG 47130 A1	20-03-1998
		US 5728228 A	17-03-1998
		US 5741365 A	21-04-1998
		US 5985810 A	16-11-1999
		US 5716456 A	10-02-1998
		US 5741367 A	21-04-1998
		CN 1051196 A ,B	08-05-1991
		JP 2651453 B2	10-09-1997
		SG 47860 A1	17-04-1998